FABRIC SOFTENER DRYER SHEET SUBSTRATE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/391,008, filed June 24, 2002.

FIELD OF THE INVENTION

The invention relates to an improvement in a nonwoven substrate for a clothes dryer fabric softener sheet.

BACKGROUND OF THE INVENTION

A popular method of applying fabric softener to clothes involves the use of dryer-activated fabric softener sheets. These sheets are placed in an automatic clothes dryer with a load of freshly washed clothes. The dryer sheet comprises a nonwoven fabric substrate that has been impregnated with a fabric softener composition that is released as the clothing is tumbled in the dryer during the heated drying cycle.

Extensive research and development efforts have gone into engineering the nonwoven fabric substrate so that it will meet a number of very demanding performance criteria. For example, in order to meet consumer acceptance requirements, the nonwoven fabric substrate must have a soft feel after use when the consumer removes the sheet from the dryer. The nonwoven fabric substrate must have a sufficient surface area of fibers present so that the nonwoven fabric substrate will receive and retain the required amount of fabric softener coating composition. Additionally, the fibers that make up the nonwoven fabric must create a sufficiently open fabric structure to receive and hold the coating composition. Not only must the nonwoven fabric be capable of receiving and holding a sufficient amount of the coating composition, it is also critical that the coating composition be released at a controlled rate during the drying cycle, which typically takes about 40 to 90 minutes. The nonwoven fabric structure must meet specified thickness requirements, so that the coating composition will be held within the thickness of the nonwoven sheet. Proper packaging of the dryer sheets also requires that substrate material meet thickness specifications. It is also important for the nonwoven fabric substrate to meet specified tensile strength and elongation requirements, so that the fabric

substrate will withstand handing during manufacture of the fabric softener sheets and during subsequent use.

United States patent 5,470,492 is directed to a fabric softener dryer sheet. This patent teaches that in order to achieve the above noted performance and consumer acceptance criteria, the nonwoven fabric substrate must have a basis weight of 0.52 to 0.58 ounce per square yard, preferably 0.53 to 0.57 ounce per square yard, and more preferably 0.54 to 0.56 ounce per square yard. The patent further teaches that the fibers should have a denier of from about 2 to about 6, preferably 3 to 5, and the fabric substrate should have a thickness of from about 0.16 mm to about 0.22 mm.

A subsequent patent, United States patent 5,883,069 teaches that the properties of a dryer sheet can be improved by increasing the thickness of the fabric substrate and its void volume and loft. According to the teachings of this patent, larger denier fibers are employed, and the basis weight of the fabric is increased somewhat to about 0.53 ounce per square yard to 0.59 ounce per square yard.

According to United States patent 5,929,026, further improvements in the nonwoven fabric substrate were obtained by changes in the manufacturing process for the nonwoven fabric. The draw roll speed was increased from about 5 percent to about 10 percent and the spinneret denier size was also increased. The basis weight and thickness of the nonwoven fabric substrate remain about the same.

While the above noted patents have moved in the direction of an increase in the basis weight of the nonwoven fabric substrate material, it has now been found in accordance with the present invention that it is possible to make a very significant reduction in the basis weight of the nonwoven fabric substrate and yet to maintain the critical performance criteria required for a dryer sheet substrate fabric. This provides significant economic advantages over the dryer sheet substrate fabrics heretofore available. Surprisingly, the softener release rate and other performance criteria are not adversely affected.

SUMMARY OF THE INVENTION

Thus, according to the present invention there is provided a nonwoven fabric substrate for a clothes dryer fabric softener sheet. The nonwoven fabric substrate is formed from substantially continuous filaments having a denier in the range of 2 to 12

denier per filament. The filaments include matrix filaments formed of polyester homopolymer and binder filaments formed of a polyester copolymer. A multiplicity of bonds exist throughout the fabric at locations where the binder filaments contact other filaments. These bonds integrate the fabric into a coherent nonwoven fabric with a grab tensile strength of at least 6 pounds per inch in the machine direction, and preferably at least 7 pounds per inch, and at least 3.5 pounds per inch in the cross direction, preferably at least 4.5 pounds per inch. The fabric has a basis weight of no more than 0.50 ounce per square yard and a thickness from about 0.180 mm to about 0.200 mm, preferably 0.190 mm to about 0.195 mm.

DETAILED DESCRIPTION

The nonwoven fabric substrate of the present invention is a polyester spunbond nonwoven fabric having a basis weight of no more than 0.50 ounce per square yard, preferably from about 0.46 to about 0.50 ounce per square yard and most preferably about 0.48 ounce per square yard. The fabric is formed by the spunbond process from substantially continuous filaments having a denier within the range of 2 to 12 denier per filament. In one specific embodiment, the filaments are from 5 to 7 denier per filament and the nonwoven fabric has a thickness of about 0.190 mm to about 0.195 mm.

The nonwoven fabric is manufactured by extruding molten polyester polymer as filaments from a plurality of fine capillaries of a spinneret. The molten filaments are quenched by contact with a coolant gas, such as air, and the filaments are then directed over draw rolls that mechanically draw the filaments to orient the polymer molecular structure and increase filament tenacity. The filaments are randomly deposited on a collection surface, such a moving belt to form a nonwoven filamentary web, and are thereafter bonded together to form a nonwoven fabric.

The nonwoven fabric substrate of the present invention includes about 80 to 95 percent by weight matrix filaments formed of a polyester homopolymer, preferably polyethylene terephthalate, and from about 5 to 20 percent by weight binder filaments formed from a polyester copolymer. Preferably, the polyester copolymer is copolyester containing ethylene terephthalate and ethylene isophthalate units.

The web of randomly deposited loose filaments is directed by the conveyer into and through a steam consolidator where saturated steam at atmospheric pressure is

brought into contact with the web. As the unbonded web of filaments passes through the steam consolidator, it is held in place between the moving belt and the surface of the consolidator drum while steam is directed into and through the web. The web is held in place with minimal pressure between the consolidator drum and the belt in order to avoid compression of the web and reduction of its thickness. The web is not directed through nip rolls or pressure rolls.

In manufacturing processes heretofore used for producing dryer sheet substrates, the surface temperature of the steam consolidator has been maintained at a temperature at or above 100° C. In accordance with the present invention, the thickness of the web in the consolidator is controlled by operating the consolidator drum at a surface temperature below 95° C. This reduction in surface temperature results in a significant increase in the final thickness of the web. To maintain a drum surface temperature below 95° C, it has been discovered that it is necessary to reduce steam flow to both the consolidator chest and drum. The collection belt is operated at a higher linear speed than heretofore so that the basis weight is reduced significantly to 0.50 ounce per square yard or lower. The reduced basis weight coupled with the increase in the thickness surprisingly provides a product which has the necessary openness and thickness required for optimal dryer sheet performance, despite the reduction in basis weight, and with no other adverse effects upon the fabric physical properties.

After the consolidated web leaves the steam consolidator, it is directed through a hot air bonder. Temperatures in the bonder are typically in the range of about 235° C to 239° C. Residence time of the web in the hot air bonder is preferably between 0.45 and 0.55 seconds.

The steam consolidator provides the web with sufficient strength to allow it to be transferred to the bonder. The elevated temperature conditions inside the bonder cause the polyester copolymer binder filaments to soften.

Test Methods:

Grab Tensile Strength is measured in accordance with the test method described in ASTM 4632-96. Fabric samples 4 inches by 8 inches are die cut using a Hytronic cutter. Tensile testing was performed on an Instron test instrument using a clamp gauge of 3 inches and a crosshead speed of 12 inches per minute.

Fabric Thickness is measured in accordance with ASTM D1777-75 using an Emveco 210A microgauge.

EXAMPLE 1

The fabric softener finish release properties of the nonwoven substrate of the present invention were evaluated and compared with the release properties of heavier basis weight substrate fabrics of the prior art. The substrate of the present invention was produced at consolidator steam flows of 9000 pounds per hour chest and 9 pounds per square inch drum pressure. The prior art samples, in contrast, were produced at 12,000 pounds per hour chest steam flow and 12 pounds per square inch drum pressure. In this test, samples of the substrate fabrics were coated with equal amounts of softener finish composition. Sheets were placed in a conventional clothes dryer with a load of clothes and the dryer was operated through a drying cycle. At intervals, sheets were removed and weighed and the weight loss from the dryer sheet was determined. The dryer sheet of the present invention indicated as sample 1 in Table I below, had a basis weight of 0.48 ounce per square yard, a thickness of 0.192 mm, and was formed of 6 denier per filament trilobal cross section filaments. Control fabric A had a basis weight of 0.52 ounce per square yard, a thickness of 0.191 mm, and was formed from 6 denier per filament trilobal cross section filaments. Control fabric B had a basis weight of 0.54 ounces per square yard, a thickness of 0.196 mm, and was formed from 6 denier per filament trilobal cross section filaments. The percent release of the fabric softener composition for those various samples is set forth in Table 1 below and is plotted graphically in Figure 1, showing percent release versus time in the dryer. It will be seen that the finish release characteristics of the substrate of the present invention compare quite favorably to that of the control prior art sheets.

Table I

Percent Release of Softener Composition

Elapsed Time	Sample 1	Control A	Control B
5	11.17%	13.52%	35.98%
10	43.99%	42.63%	64.39%

15	58.47%	64.42%	76.21%
20	68.61%	72.41%	81.85%
30	79.72%	82.71%	88.69%
45	88.36%	88.35%	94.67%
60	92.52%	91.86%	96.17%
75	94.01%	94.18%	98.00%

Example 2

The physical properties of the nonwoven substrate of the present invention and the prior art substrate of Control B were measured and the results are compared in Table II below.

Table II

Test	The Inv.	Control B
Frazier Air Permeability	1897	1658
Thickness (mils)	7.56	7.7
Basis Weight (oz:/yd2)	0.48	0.54
MD Dry Heat Shrinkage (%)	0.33	0.72
XD Dry Heat Shrinkage (%)	-0.74	-0.37
MD Sheet Grab Tensile (pounds/in.)	7.89	9.56
MD Sheet Grab Tensile Elongation (%)	50.06	49.88
XD Sheet Grab Tensile (pounds/in.)	5.02	6.57
XD Sheet Grab Tensile Elongation (%)	63.44	61.31
MD Strip Tear	2.63	3.72
XD Strip Tear	3.66	4.75
Belt Fuzz	2.40	2.44
Jet Fuzz	3.68	3.62